The CRUSHED STONE JOURNAL

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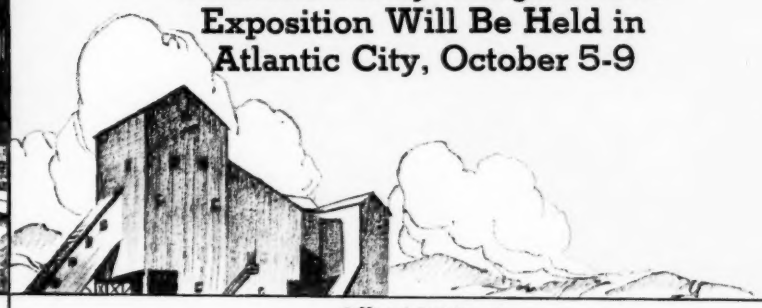

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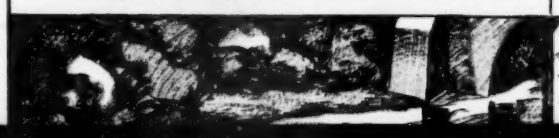

ANNOUNCING

Twentieth Annual Convention
National Crushed Stone Association

Netherland Plaza Hotel ❖ Cincinnati, Ohio

JANUARY 18, 19 and 20, 1937

In conjunction with which will be held

THE MANUFACTURERS' DIVISION EXPOSITION OF MACHINERY, EQUIPMENT, AND SUPPLIES

THE Annual Convention of the National Crushed Stone Association has, during the years since its inception, become recognized as an event of outstanding significance to crushed stone producers individually and to the industry as a whole.

It serves, as no other medium can, to develop, crystallize, and express industry opinion. It signifies solidarity of purpose and the ability of those engaged in the same line of activity to unite in the solution of common problems.

As individuals, producers will find much to reward them for a visit to Cincinnati next January: Speakers of outstanding reputation and experience will discuss problems of timely interest, both technical and legislative; opportunity will be afforded for the mutually beneficial exchange of opinions with fellow-producers, to say nothing of the pleasure to be derived from renewing old acquaintanceships; the Manufacturers' Division Exposition will command studious attention for the helpful suggestions to be obtained from an inspection of the latest developments and improvements in machinery and equipment used in the crushed stone industry.

ALL crushed stone producers of the United States and Canada, whether or not members of the National Crushed Stone Association, are cordially invited to attend our Twentieth Annual Convention. Make your plans now to be present at Cincinnati on January 18, 19 and 20, 1937.

For further information write to the

NATIONAL CRUSHED STONE ASSOCIATION

1735 Fourteenth Street N. W. · · Washington, D. C.

The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

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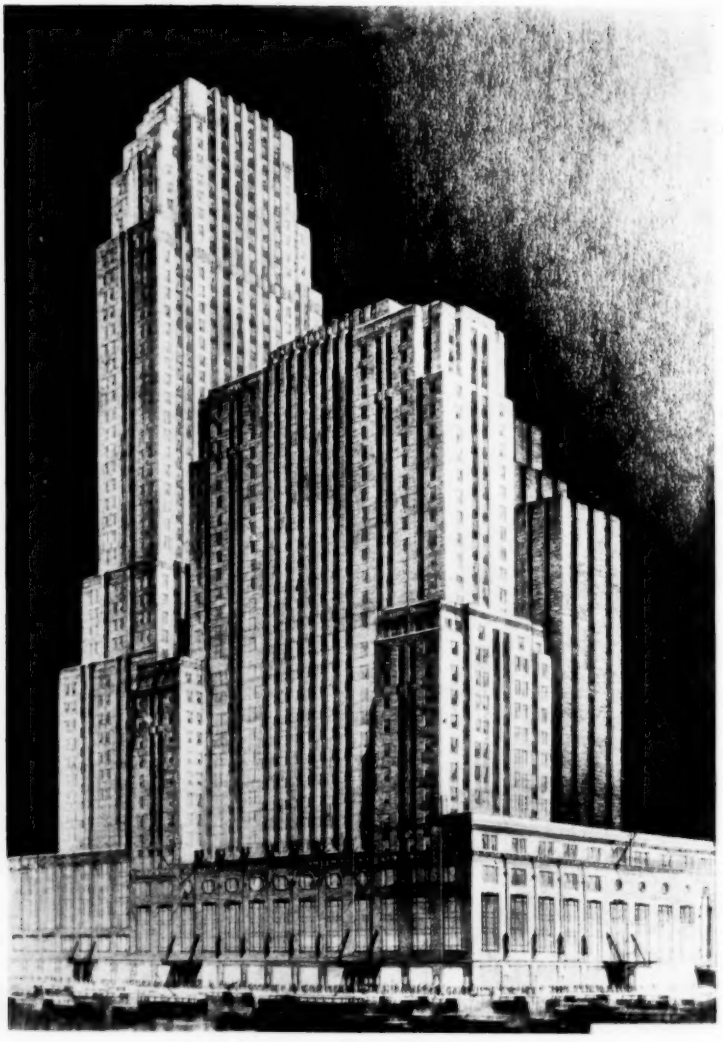

Netherland Plaza Hotel, Cincinnati, Ohio, where the Twentieth Annual Convention of the National Crushed Stone Association will be held on January 18, 19 and 20, 1937

THE
CRUSHED STONE JOURNAL
WASHINGTON, D. C.

Vol. XI No. 6 AUGUST-SEPTEMBER, 1936

Cincinnati Selected for Twentieth Annual Convention

◆ Board of Directors Holds Mid-Year Meeting at Hot Springs, Virginia. Detailed Reports on Activities During First Half Year Submitted by Executive Officers

THE Twentieth Annual Convention of the National Crushed Stone Association will be held at the Netherland Plaza Hotel, Cincinnati, Ohio, on January 18, 19 and 20, 1937, in accord with decisions reached at the mid-year meeting of the Board of Directors, held at Hot Springs, Virginia, on July 24. Chosen from a wide field of contestants desirous of the honor of acting as host for our next annual meeting, Cincinnati needs no introduction to the members of the National Crushed Stone Association, as it will be pleasurably recalled that previous annual meetings have been held in the Queen City with outstanding success. Cincinnati enjoys a particularly favorable location as a vast majority of the industry can leave for the convention in the late afternoon or early evening and arrive the next morning in ample time to get settled before the opening gavel calls the first session to order. Its selection should prove particularly popular to those located at relatively distant points, as excellent train facilities and connections are available from all territories. Prompted by an earnest desire to make attendance at the meeting next January economically attractive, the easy accessability of Cincinnati unquestionably exercised an important influence upon the decision of the Board.

Not only does Cincinnati enjoy outstanding advantages as to location, but as well because of the excellent convention facilities afforded by the Netherland Plaza Hotel, officially designated as convention headquarters. This widely known hostelry meets to an unusual degre the various requirements which experience has determined are essential for a smooth-running and successful convention. Adequate accommodations to house all delegates have been guaranteed by the management at rates which are certain to prove attractive, beginning as low as $3.00 per day single or $2.50 when occupied double. Its public space was especially designed for the accommodation of conventions, thus making it possible to concentrate practically all convention activities on one floor. Spacious and attractive quarters are available for the holding of the general sessions of the convention, while an unusually large number of private dining rooms can be utilized for luncheons and group meetings. Facilities for housing the Manufacturers' Division Exposition, for many years a feature of the annual meeting, lack nothing to be desired, it being particularly worthy of note that large sized equipment can be placed in the exhibit hall with unusual ease, thus holding the cost of exhibiting to a minimum.

Excellent meals will be available throughout the convention period in a number of different dining rooms in the hotel and at a range in price certain to meet with popular approval. Lowest prices will prevail in the famous Netherland Plaza coffee shop, where breakfast can be obtained at $.30, $.50 and $.65, luncheon at $.50 and $.70, and dinner at $.85 to $1.25.

Plans for the convention next January are being developed along lines which prevailed during the years before NRA. Under the Code regime much of the intimacy and camaraderie which contributed so

largely to the enjoyment and pleasure of the annual meeting was unavoidably forced to the background under pressure of the wide variety of matters involved in Code administration and demanding attention during the convention period. The coming Cincinnati meeting should witness a reawakening of the esprit de corps of the crushed stone industry and we know of no more appropriate surroundings in which to develop industry pride and solidarity than amidst the hospitable and friendly atmosphere of the Netherland Plaza.

As previously stated, the Manufacturers' Division of the Association will hold its annual exposition of machinery, equipment, and supplies used in the production and distribution of crushed stone. Since its inception the Exposition has commanded a well deserved position of outstanding interest as an important feature of the annual meeting. Every signpost points to a most successful exposition next January. The crushed stone industry is definitely on the up-swing. A vast potential market for new equipment and replacements has accumulated during the years of the depression which, even now, is showing signs of real activity. An unparalleled opportunity, therefore, exists for manufacturers to capitalize upon the favorable reaction of this market. We confidently anticipate a demand for exhibit space far in excess of the facilities used last year. A cheering note to prospective exhibitors should be the definite sentiment prevailing at the meeting of the Board of Directors, as expressed by a number of those present, that they intended to resume the practice of bringing their operating men and superintendents to the convention. At no other time throughout the year does the manufacturer enjoy such a favorable opportunity for bringing his products to the intimate attention of the leading executives and operating men of the industry.

With the convention centrally located, adequately housed, and everything possible being done to make attendance economical, instructive, and enjoyable, every member of the industry should make his plans now to foregather with his fellow producers at Cincinnati next January.

In addition to determining the date and place for the next annual convention, the mid-summer meeting of the Board of Directors gave consideration to a number of other matters of importance and interest to the industry. First, let it be said that attendance at the meeting was highly gratifying, both from the point of view of the number present and also with regard to geographical representation. Originally scheduled to take place at French Lick, Indiana, it was deemed advisable, as previously announced, to shift the meeting to Hot Springs, Virginia, in view of the unfavorable weather conditions prevailing in Middle Western territory during the period immediately preceding the date of the meeting. Notwithstanding this last minute change in location, necessitating a serious readjustment in the plans of some members from the Middle West, attendance came up to expectations as will be noted from the following list of those who were present:

Members of the Board

H. E. Rodes	H. E. Rainer
W. M. Andrews	Russell Rarey
L. J. Boxley	J. A. Rigg
J. R. Boyd	F. W. Schmidt, Jr.
F. O. Earnshaw	John W. Stull
A. T. Goldbeck	Stirling Tomkins
Otho M. Graves	T. I. Weston
E. J. Krause	A. L. Worthen
Thos. McCroskey	C. S. Huntington

Others

A. W. McThenia S. A. Phillips N. C. Rockwood

Though it has been said frequently before, we cannot overlook the opportunity of again commenting upon the fine spirit of cooperation and self-sacrifice which has for so many years characterized the members of our Board. To leave their personal affairs during the midst of the busy season and travel substantial distances at their own expense in order to assist, by their counsel and advice, in the administration of the Association, is typical of the unselfish devotion which prompts these men to place the interests of the industry ahead of their own personal desires, the foundation upon which the continued success of effective organized effort in the crushed stone industry so surely depends. The industry is deeply indebted to the members of the Board who, year after year, give of their time and money in order that the interests of the entire industry may be safeguarded and advanced.

Immediately following the opening of the meeting, called to order by H. E. Rodes, Chairman of the Board and President of the Association, action was taken appropriately expressing the sincere regret of the Board at the untimely passing of Gordon Buchanan, elected as Chairman of the Manufacturers' Division at the St. Louis Convention last January. Mr. C. S. Huntington, Link-Belt Co., Chi-

cago, Illinois, elected to fill the unexpired term of the late Mr. Buchanan, was introduced to the meeting and qualified to sit on the Board as a representative of the Manufacturers' Division.

At the request of Chairman Rodes, Otho M. Graves, who, with Russell Rarey, represented the National Crushed Stone Association on the Board of Governors of the Mineral Aggregates Institute, submitted a detailed account of the circumstances surrounding the action taken by the Board of Governors of the Institute in dissolving that body at the meeting held in Washington on March 13, 1936. The Board voiced its unqualified endorsement of the manner in which this situation had been handled by Messrs. Graves and Rarey.

Reports were then submitted by Administrative Director J. R. Boyd and Engineering Director A. T. Goldbeck covering the activities of their respective departments during the first half of the year. The Board recorded its approval and appreciation of the reports as submitted, details concerning which will not be given at this time, as reports covering the full year's activities will be submitted by both Messrs. Goldbeck and Boyd at the time of the annual convention. In passing, it may be appropriately pointed out, however, that the plan inaugurated during the early part of the year, after approval by the Executive Committee, providing for a wider and more frequent dissemination of the information developed through the Bureau of Engineering, paralleling a more intensive effort to increase Association income through a building up of the membership, received the enthusiastic support of the Board. It was also encouraging to learn from the Administrative Director that the financial condition of the Association at the close of the first six months' period was substantially stronger than at the beginning of the year and that further progress in this direction is anticipated during the second six months. The vitality of the discussion which followed the presentation of Mr. Goldbeck's report again attested to the value and importance of the research and promotional activities of the Association.

Certain fiscal policies were established by the Board as an aid to more effective administration of Association affairs. By resolution the principle was adopted that in reporting tonnage figures for the purpose of determining the basis on which active membership dues should be predicated, members may exclude "captive tonnage" when such tonnage is clearly chemical and metallurgical in character. In order that tonnage information may be tabulated and analyzed well in advance of the annual convention next January, it was decided that in soliciting such information from members for the purpose of determining the basis of dues that the figures should cover the twelve months' period ending October 31, instead of being applicable to the calendar year as in the past. In view of the fact that a substantial portion of the industry is largely inoperative during November and December, the change in the tonnage period should exert no important effect upon the total figures and yet enjoys the advantage of making possible much greater accuracy in the prediction of annual income which is a vital part of the budgetary report submitted at the annual meeting.

The following applications for active membership in the Association were submitted and unanimously approved:

Dominion Mines and Quarries Co., Toronto, Canada

New Castle Lime and Stone Co., New Castle, Pa.

Tarbox-McCall Stone Co., Findlay, Ohio

To these companies we take the opportunity of extending a most cordial welcome. All having been members of the Association in the past, their reaffiliation is cause for real gratification.

The Administrative Director submitted for the consideration of the Board the invitation of Mr. Frank Bane, Executive Director of the Social Security Board, to our industry to register voluntarily employees in advance of January 1, 1937. This question was discussed at considerable length by various members present, resulting in the Board's finally concluding that, in view of all of the circumstances, this matter was one for individual handling with the Social Security Board by member companies.

The activities of the National Housing Advisory Council were then discussed briefly by Administrative Director Boyd, largely for the purpose of ascertaining to what degree members of the Association were interested in activities of this type. It was suggested that a questionnaire on the subject be sent out to member companies in order that there might be developed a list of names of those interested in receiving releases from the National Housing Advisory Council. In the near future such a questionnaire will be mailed to the membership and we urge that it be given prompt handling.

The meeting concluded with a general discussion of the Walsh-Healey Government Contracts Act and

the Robinson-Patman Price Discrimination Act, both of which measures are of vital concern to crushed stone producers; as in the past it will be the policy of the Association to keep member companies fully informed as to important developments concerning these two Acts.

In concluding this brief account of the mid-summer meeting of the Board, let us again direct attention to the Twentieth Annual Convention of the Association which will be held at the Netherland Plaza Hotel, Cincinnati, Ohio, January 18, 19, and 20, 1937 and urge upon every member the desirability of making plans now to attend this important event. Located within an overnight ride for the vast majority of the members of the industry, housed in a hotel exceptionally well equipped to meet our requirements, with rooms and meals available at prices which are certain to meet popular approval, and with railroad rates which guarantee economical transportation to the meeting—we confidently anticipate a meeting next January which will prove more successful from every point of view than any held in recent years.

Motor Vehicle Registrations Gained in 1935

MOTOR vehicles registered in the United States in 1935 numbered 26,221,052, an increase of 5 per cent compared with 1934 registrations, according to reports from state registration agencies to the U. S. Bureau of Public Roads. Registration revenues, fees, etc., amounted to $322,776,500.

The total registration was composed of 22,565,347 passenger cars, taxicabs and buses, and 3,655,705 trucks. The number of buses reported—29,527—is less than the actual number, since in many states buses are not reported separately.

States with the greatest percentage of increase in registrations were Montana, 16.7 per cent; South Carolina, 16.3; New Mexico, 11.5, and Louisiana, 10.2. Only two states, Massachusetts and Nebraska, reported decreases, and these were slight.

The five states with the largest total collections were New York, $43,453,082; Pennsylvania, $32,155,367; Ohio, $22,153,123; Illinois, $19,075,621, and Michigan, $17,594,552. Nevada, with $262,464 and 34,858 vehicles registered, was at the bottom of the list.

Association's Bulletin No. 10, "Stone Sand," is Enthusiastically Received

ENGINEERING BULLETIN No. 10 entitled "Stone Sand", by A. T. Goldbeck, Engineering Director, National Crushed Stone Association, which has just been published, is being accorded an enthusiastic reception by both producers and users of crushed stone. This publication brings together for the first time under a single cover a wide variety of data concerning the production and use of stone sand and obviously fills a long-felt need for information of this character. Particularly gratifying is the very real interest being manifested by highway and construction engineers which is evidenced by the highly complimentary observations we are receiving almost daily from such sources.

Stone sand for a number of years has been struggling for a place in the sun as a fine aggregate and our latest engineering bulletin should markedly accelerate the well-merited recognition of this product as an acceptable material of construction.

This Bulletin should be of especial value to stone producers in the promotion of the more extensive use of stone sand for not only does it show by means of laboratory tests how satisfactorily concrete may be made with this material, but further gives tangible evidence of the durability of stone sand concrete through illustrations of structures which have long been exposed to the weather with no indications of failure.

To serve most effectively the interests of crushed stone producers Bulletin No. 10 must be given the widest possible distribution among highway officials, construction engineers, and contractors. The degree to which the membership is cooperating in effecting local distribution is most gratifying. Hundreds of copies have already been purchased. At this writing, however, we find that a number of member companies have not as yet advised the Washington office of the number of additional copies they will require to make Bulletin No. 10 available to all potential customers in their territories. We therefore wish to urge each member who has not already done so to forward to the Washington office immediately the order blank which accompanied the announcement of Bulletin No. 10 to member companies.

Can the Durability of Concrete Roads be Improved by Revised Construction Methods?

By A. T. GOLDBECK

Engineering Director
National Crushed Stone Association, Inc.

◆ Durable concrete is of fundamental importance in exposed concrete structures. A concrete highway is subjected to severe exposure and there are many causes which can make for lack of durability. The present article discusses one possible cause and suggests the high importance of experiments in construction methods as a means for determining how to make concrete highways even more durable than at present.

AT THE outset let it be fully understood that the following discussion is intended to be solely constructive, even though it deals with a defect in the concrete type of pavement. If it stimulates not only thought, but also action toward the production of more durable pavements, it will have served its purpose.

Concrete highways, considered as a whole, have given satisfactory service. They have been worth their cost. But defects have appeared and sometimes they have been so serious as to greatly shorten the life of the pavement. In the northern States highway engineers are familiar with the "scaling" of concrete road surfaces, that is the peeling off of surface layers of mortar followed sometimes by complete disintegration of the concrete. It is this particular defect which will be discussed, for its cure is very earnestly to be desired.

There are several forms of scaling. A light scale may result from laitance formed on the surface of the concrete during the finishing operation, or from deposits of fine inert material carried in suspension by mixing water flowing upward through the mass of concrete after it is in place. As a rule, this form of scaling is unimportant. There may be scaling from other causes such as the effect of abrasive materials and chemicals. These are effects which are not due inherently to the physical characteristics of the concrete. This form of scaling can be minimized by eliminating as nearly as possible, causes which are fairly well known. That type of scaling which is most important is the serious, progressive scaling as illustrated in Fig. 1, which ultimately leads to disintegration of the concrete.

An attempt will be made in the following discussion to consider some of the probable causes of progressive scaling and to indicate the path to a remedy. The problem is not new; engineers have been struggling to overcome this scaling difficulty for at least 15 years. Concrete roads still scale; the problem is still with us and seemingly is a difficult one. No pretense is made that a complete solution is at hand, but the writer has at least given the matter some thought and has made some investigation of the subject.

In approaching the analysis of progressive scaling, perhaps it will be well to trace the possible causes beginning with the constituent materials of the concrete; the placing and finishing of the concrete slab, and the subsequent effects of traffic and weather during years of service.

Constituent Materials

(a) Cement. There has been considerable discussion about the relative durability of the present day higher limed, harder burned, finer Portland cement as compared with the product of former years. Into the merits of either side of that discussion, the writer will not attempt to enter. However, scaling of concrete roads has not been confined to those built with

Figure 1
A Badly Scaled Concrete Road Surface

the present type of Portland cement. Modern cements of different brands differ from one another in respects which may affect the problem of scaling; they have different degrees of workability, different water retaining capacities, different degrees of shrinkage, different strengths, etc.

(b) Fine Aggregate. Fine aggregate may be one of the causes of scaling, especially if it has an excessive amount of unsound particles which will subsequently expand and exert disrupting action. Excessive clay or silt is not desirable. Both may produce a weak surface layer and generally weak concrete when used in rich mixtures. Organic matter may prove to be decidedly detrimental. These defects in fine aggregate are now well recognized and proper precautions can be taken to obtain satisfactory sands. Let it be fully understood, however, that a certain amount of comparatively deleterious material may have no bad effect if the mortar is strong and dense. Gradation may play its part. Water gain is notable in concrete made with fine aggregates which are lacking in fine particles. Gradation greatly affects workability which in turn influences the quantity of water used to obtain the degree of placeability and finishability desired.

(c) Coarse Aggregate. Reasonable soundness of coarse aggregate is necessary for producing sound concrete. However, it is not believed that the coarse aggregate is so very important in its contribution to the scaling problem, unless it is so smooth as to lose its bond with the mortar in the course of time. Coarse aggregate may be a contributing cause, but generally it is not a primary cause of scaling.

(d) Mixing water. This may be dismissed from consideration as far as its quality is concerned. There doesn't seem to be any excuse for using mixing water so inferior in quality that it will cause disintegration of the concrete. Certainly, the scaling which has occurred is not attributable to the mixing water.

The Concrete

Concrete road mixtures usually are made fairly rich in cement, in recognition of the severe exposure and traffic conditions to which they will be subjected. An effort usually is made to proportion the mix so as to obtain a plastic mass which may be finished satisfactorily without too much effort. If an excessive amount of sand is used too much mortar will be brought to the top during finishing and this should be avoided.

It is generally considered that approximately 2 gallons of water per sack of cement is sufficient to bring about hydration. If concrete were made with so low a water content it would not be plastic but would be stiff, harsh working and badly honeycombed, especially on the bottom of the slab. Great difficulty would be had in bringing about a proper surface finish. To overcome such difficulties more water must be used than is actually needed for hydration. Six gallons of water per sack of cement is not unusual. Roughly speaking then, the concrete contains four more gallons of water than is necessary to cause the cement to hydrate and harden properly. Here is a very tangible source of weakness, for the extra water occupies space and when it disappears, either by flowing out of the mass or by evaporation, undesired porosity may result.

The concrete is placed on the subgrade and is struck off to the level of the forms, either by hand or by machine and it is observed that after the striking off process the surface becomes exceedingly wet, so much so in fact that clear, free water may exist or actually run off the surface of the concrete. An effort is usually made to get rid of this excess water, sometimes by the use of a light sheet metal hand-roller or by squeegee action; finally, the surface is belted and after the belting, water may continue to rise to the surface and cause an excessively wet surface layer. In the course of time the surface becomes drier, either by evaporation or by absorption and at this stage in some States a special surface finish is given by the use of brooming.

It is not difficult to see why the water comes to the surface. A concrete mixture contains solids whose specific gravities are higher than that of water. Portland cement may be considered as having an average specific gravity of 3.12; siliceous sand of 2.65, and coarse aggregate may vary in specific gravity from roughly 2.40 to 3.0, depending upon its characteristics. Water may be taken as having a specific gravity of 1.0. Quite naturally, in a plastic mass the heavier particles tend to settle and to displace the fluid portion of the mass. The water cannot flow readily downward for it is stopped by the subgrade. It takes the path of least resistance and flows upward and accumulates at the surface. This accumulation of water at the surface of the concrete is readily observed on practically every concrete road paving job. If it is assumed that the solids, consisting of cement, fine and coarse aggregates, retain their same relative positions after settlement

takes place, it would seem to be a foregone conclusion that the upper layer of the concrete pavement must attain a higher water cement ratio than the lower layers.

Laboratory Experiments

Although field conditions cannot be duplicated exactly in the laboratory on small specimens, at least some rather indicative results may be obtained to show what might be expected from the concrete in a road slab when it is placed and finished in different ways. No engineer familiar with concrete would question the great desirability of obtaining a concrete road slab which is as dense and non-porous as practicable. One of the ways of accomplishing this end is to lay the concrete with a mixture containing enough water to well lubricate the mass so as to create a plastic consistency and then later extract the excess water and also take steps to bring the solid particles closer together so as to leave no air voids or shrinkage cracks due to the extraction of the water. With vibration and with some of the new hopper machine methods of placing concrete, a very much dryer mixture may be employed than with the older but still almost universally used methods of placing and finishing. With these newer methods there will be a smaller excess of water to be extracted from the concrete after placing.

In any event, a plastic mix after being placed can be made much denser if the excess water is extracted and if, at the same time, the particles of solid matter are brought together so as to occupy the space formerly occupied by the excess water. A few tests were made in the laboratory of the National Crushed Stone Association to determine the feasibility of reducing the water content after the concrete had been placed.

(a) Mortar Beam Specimens

Three beams were made employing mortar in the proportions of one part of cement to two parts of stone sand. The water ratio used in the mixture was 0.8. The beams were 6 by 6 in. in cross-section and 3 ft. long.

The first beam was made in the normal manner in a comparatively water-tight mold. After placing and rodding the mortar it was floated with a wooden float, then with a steel trowel.

The second beam was made with the idea of attempting to drain the water from the bottom of the form, and, also, by manipulation to create a dense concrete. Stone screenings free from dust were spread to a thickness of ½ inch in the bottom of the form before placing the concrete. This porous layer created a reservoir into which part of the excess mixing water from the concrete could drain. The mortar was placed and finished as in the first beam. At the end of ½ hour the mold was tilted to let the water which had come to the top, run over the sides. The mortar had settled ¼ inch at the end of ½ hour, indicating some compaction of the solids to replace the displaced water. The top of the beam was again floated at the end of 2, 4 and 6 hours.

Beam No. 3 was intended to simulate the Johnson method of finishing.[1] The concrete for this beam also was laid on a ½ inch layer of stone screenings to drain away the excess water reaching the bottom of the beam. After the initial troweling and at the end of 10 minutes a dry 1:1 cement-sand mixture was trowelled into the surface at the rate of about 1 lb. per sq. ft. This beam was again slightly trowelled at the end of about 3½ to 5½ hours.

(b) Tests of Mortar Beams

The three above described beams were sampled at the end of 3½ hours for the purpose of determining the water content in the mortar at different depths. The sampling was accomplished by taking samples of the mortar by the process of removing the mortar to successively increasing depths of ½ in. The samples were then oven dried at 220 F. to determine their moisture content. Finally the water-cement ratio was calculated for each of the samples.

TABLE I

Depth of Sample (inches)	Beam No. 1 Normal Finish ½ hr.	Beam No. 1 Normal Finish 3½ hr.	Beam No. 2 Delayed Finish Drainage at Bottom of Beam 3½ hr.	Beam No. 3 Johnson Method Drainage at Bottom of Beam 3½ hr.
	Water-Cement Ratios at End of Stated Periods			
0 - ½	0.85	0.84	0.89	0.70
½-1	.85	.79	.84	.76
1 -1½	.86	.71	.81	.76
1½-2	.82	.79	.73	.76
2 -2½	.83	.81	.73	.76
2½-3	.80	.82	.71	.76
3 -3½	.83	.81	.76	.71
3½-4	.79	.85	.76	.70
4 -4½	.79	.80	.77	.70
4½-5	.77	.78	.75	.77
5 -5½	.76	.83	.77	.75
5½-6	.70	.79		

[1]Described in the 1927 Proceedings of the American Concrete Institute, p. 458.

No great claim is made for extreme accuracy in the results given in Table I. These tests should be repeated many times to insure thoroughly reliable average values. However, granting the possibility of some inaccuracy due to faulty technique in taking the moisture samples, the table still indicates some very significant facts as follows:

1. That in normal finished concrete (Beam No. 1), there is a higher water-ratio in the top of the slab than elsewhere, especially at a period of ½ hour after finishing. At this period there is a tendency for the water to increase at the top and to decrease at the bottom of the beam.
2. At the end of 3½ hours in Beam No. 1 a readjustment of the water content at different levels has taken place. There is still a very high water-ratio in the upper ½ inch layer.
3. In Beam No. 2 (delayed finishing), deposited on a ½ inch layer of porous screenings, there is a decreased water-ratio in the body of the concrete but still a high water-ratio at the top.
4. In Beam No. 3 (Johnson Method), deposited on a ½ inch layer of porous screenings, there is again a decreased water-ratio not only in the body of the concrete but also in the upper surface layer.

Strength Tests

The above beams were broken at 28 days under center loading on an 18-inch span, the top side as molded in tension, with the following average results:

	Beam No. 1	Beam No. 2	Beam No. 3
Modulus of Rupture	1070	1290	1260

These results indicate a benefit in strength to the extent of 220 lb. or 20.6 per cent and 190 lb. or 17.8 per cent for beams Nos. 2 and 3 respectively, due in part to draining away the excess mixing water and perhaps also to manipulation of the concrete to compact or densen it in place.

Absorption Tests

After breaking the beams, they were cut into slices of irregular shape about 3 in. by 6 in. on the upper and lower faces to represent the mortar at different depths in the beam. The absorption tests were made by immersing the specimens for 24 hours and then oven drying them to dry weight. The following values were obtained:

TABLE II
PERCENTAGE OF ABSORPTION

Depth of Beam	Beam No. 1	Beam No. 2	Beam No. 3
0 -¾ in.	11.7	10.7	9.5
¾-1½	11.2	9.3	9.9
1½-3	10.7	7.4	9.0
3 -4½	10.3	8.3	7.2
4½-6	10.2	7.6	8.4

The above results are approximately consistent with those in Table I. They indicate that the mortar beams have been made denser and less absorbent by the extraction of the water from the mortar and by its manipulation after it has been placed.

Bureau of Public Roads' Tests

In the October, 1933, number of *Public Roads* issued by the United States Bureau of Public Roads, there is published an article by F. H. Jackson and W. F. Kellerman entitled, "The Effect of Vibration and Delayed Finishing on Pavement Slabs". That article describes a large series of tests made on concrete deposited and finished under actual field conditions. Two series of tests were conducted. Series "A" dealt with "Tests to Determine Effect of Vibration" and Series "B", "Tests to Determine Effect of Delayed Finishing" (Johnson Method).

Reference should be made to the original article for the complete details of the tests. Briefly, however, the concrete was laid on the subgrade in the form of slabs 9 feet in width and 7 inches thick. Test beams and cylinders were also made and test beams 60 inches by 27 inches wide were removed from the slabs. They were tested on a 54-inch span with loads at the third points.

In Series "A" the slabs were finished by a standard, double screed finishing machine, equipped with three high frequency vibrators, two on the first screed and one on the rear. A bull-nose strike-off was riveted to the front screed.

In Series "B" the Johnson method of finishing was employed. This method has been used for a number of years and was proposed by Mr. T. H. Johnson of Sioux City, Iowa. The Johnson method was utilized in the Bureau of Public Roads' tests as follows:

"Immediately after the concrete was deposited on the subgrade it was struck off with a hand screed. It was then floated with a long-handled wooden float 12 inches wide, 20 inches long and 2¼ inches thick. The thickness was obtained through the use of a 1¾ inch cypress plank with a ½ inch oak plank nailed to the bottom, the oak making contact with the concrete. After floating the surface was rolled with a light-weight sheet-metal roller. The

roller was operated from side to side of the pavement and was advanced about 1 foot longitudinally with each passage. The entire surface was rolled three times, after which it was belted. This was followed by the application of the so-called "dry mix" to the surface. This mixture was made up of 1 part cement to 1 part of fine sand by volume and spread over the surface with shovels at the rate of 1 sack of cement per 20 square yards of pavement. For a 7-inch pavement this would be equivalent to increasing the total amount of cement used about 0.25 bag per cubic yard of concrete. Just enough of the mixture was applied to give a very thin continuous cover. The sand used for this purpose was the same as the fine sand used in the concrete mixture and contained approximately 5 per cent of moisture when mixed with the cement. After an interval of 11 to 50 minutes, depending upon the amount of water brought to the surface by the dry mix, the surface was again belted.

"The second belting was followed by floating with hand floats at intervals until there was little moisture brought to the surface and the concrete became sticky and was drawn along by the float. This general procedure was sometimes varied by belting between floating operations and by additional rollings. The number of floatings necessary to bring the surface to the required condition after the dry mix was applied varied from 3 to 7 and the elapsed time from the placing of the concrete to the final floating varied from 2¼ to 3¾ hours."

CONCLUSIONS FROM BUREAU OF PUBLIC ROADS' TESTS

For the present purposes it will suffice to quote the Bureau of Public Roads' conclusions drawn as a result of these tests:

SERIES A.—VIBRATED CONCRETE

1. By the use of vibrating equipment of the same general type as employed in connection with these tests it should be possible satisfactorily to place and finish considerably drier concrete than is possible with methods now in common use.
2. For conditions comparable to these tests, it should be possible satisfactorily to place and finish by vibration concrete having a minimum slump of 1 inch as compared to a minimum slump of 2½ inches for methods now in common use.
3. These tests indicate that, depending on the type of coarse aggregate used, concrete containing from one fourth to three fourths part more coarse aggregate than the base mix, if vibrated, should show as great uniformity and as high flexural strength as the base mix finished by methods now in common use. Such a mix will contain approximately from 0.2 to 0.6 sack of cement per cubic yard less than the base mix.
4. The indications are that the effect of vibration is more marked where angular coarse aggregates are used than where aggregates having rounded surfaces are used.
5. In general, it appears from the results of these tests that the proper use of the vibratory method of finishing should result in an improvement of the quality of concrete pavements.

SERIES B—JOHNSON METHOD

1. The use of the Johnson method of finishing as carried out in these tests will increase the density and strength of concrete pavement slabs by eliminating a larger quantity of excess water before final consolidation than is accomplished by the methods now in common use.
2. The application of the Johnson method of finishing to a mix containing approximately one half part more fine and one part more coarse aggregate than the base mix will produce pavement slabs having substantially the same crushing and flexural strength as the base mix finished by methods now in common use. Such a mix will contain approximately one sack of cement per cubic yard of concrete less than the base mix.
3. In general, the indications of these tests are that the proper use of the Johnson method of finishing should result in an improvement in the quality of concrete pavements.

In both of the above described methods an effort was made to obtain a final concrete which would be drier and denser than concrete as ordinarily finished. Apparently both the vibration method and the Johnson method were effective in accomplishing beneficial results which should lead to stronger, more durable concrete.

Effect of Water-Cement Ratio on the Resistance of Mortar to Freezing and Thawing

As further evidence of the possible benefits of adopting construction methods which will lead to drier and denser mixes as finally finished, the results of a series of freezing and thawing tests on mortars conducted by the National Crushed Stone Association Laboratory are very interesting.

The procedure in making these tests may be stated briefly. Mortar mixtures were prepared with four different sands using water-cement ratios of 0.6, 0.7, 0.8, 0.9 and 1.0. Two inch cubes were then molded from each of the mixtures, cured in the moist room for 28 days and then subjected to alternate freezing and thawing. In Fig. 2 are shown the results of 40 cycles of freezing and thawing stated in terms of percentage of loss in weight, which is taken as an index of the extent of disintegration. There is a difference in durability due to the characteristics of the sands but of principal interest is the fact that if the water-cement ratio can be kept low enough certain sand mortars would be durable which fail badly when made with a high water-cement ratio such as might be obtained at the top of a finished pavement slab.

Traffic and Weathering Effects

Certainly, tests and experience point to the very great desirability of making a special attempt to obtain dense concrete, having a low water cement ratio throughout the mass and certainly at the top of the road slab which suffers the greatest exposure and is subjected in addition to the abrasion and impact action of traffic, to the abrasion of gritty materials used in times of freezing weather and possibly under certain conditions to deleterious effects of ice removing chemicals.

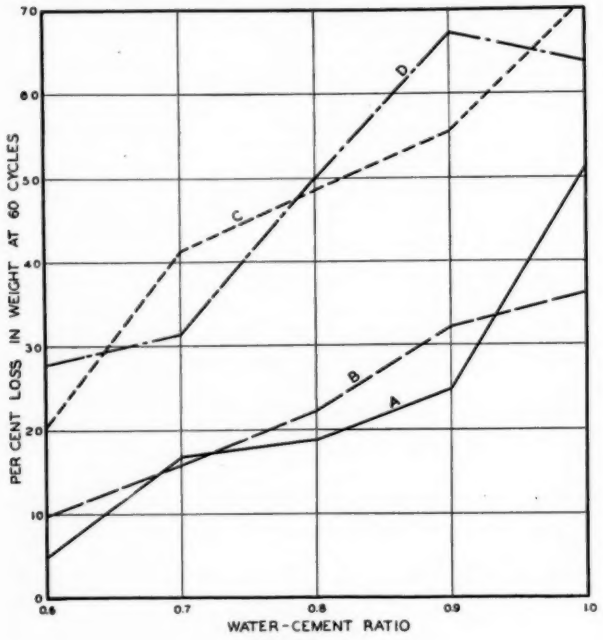

Figure 2
Freezing Tests on Portland Cement Mortars (Illustrating the important influence of water in the mixture on the resistance to freezing)

In addition to these deteriorating agencies, the surface of the slab is exposed to rapid changes in temperature and to fluctuations in moisture, both of which cause changes in length and therefore horizontal shearing stresses and possibly surface checking. Likewise, there are some indications of the deposition of salts[2] brought up in solution either from the subgrade or from the body of the concrete by capillary water, which upon evaporation becomes a saturated solution from which the dissolved salts are deposited at or near the surface of the concrete. This continuous growth of salts in crystalline form may aid in exerting disrupting action.

[2]Stabilized Soil Roads by C. A. Hogentogler and E. A. Willis, Public Roads, May, 1936.

Granting the probability of a number of causes of scaling, there is one outstanding fact, namely, that for the most part scaling takes place under low temperature conditions and freezing seems to be the most important deteriorating agent. All of the evidence also leads to the conclusion that high density and strength as produced in concrete by low water-cement ratio are important attributes of durable concrete and hence the question arises whether present construction methods are not in need of alteration so as to produce higher quality concrete, not only in the lower part of the slab, but also in the top surface as well.

With the above objective in mind it is suggested that highway building agencies set aside certain of their concrete highway projects as experiments in construction methods, employing those schemes of construction which will result in denser, stronger concrete, especially at the surface of the slab. Among these schemes the following are suggested:

1. The use of a granular layer under the slab to drain away excess mixing water. This layer should be just thick enough to contain a volume of voids sufficient to hold the excess water. One full, effective inch of screenings or similar stable, porous material would be sufficient. Coupled with the use of this layer, some form of delayed finishing should be used to close up shrinkage cracks resulting from the removal of excess water. Finally, a dry cement-sand mixture, as little as practicable, should be employed to blot up the surface water and thus lead to a dense, high strength surface layer of low-water ratio. It is believed that the thin subgrade layer of porous material would be effective also in preventing capillary water from continuously feeding up through the slab. The delayed finish might be done by machine, using either the ordinary finishing machine or a vibration machine.

2. The use of vibration, employing a concrete mix suitable for that method of placing and finishing. This requires a reduction in sand and mixing water and an increase in coarse aggregate. The excess mixing water which rises to the surface may have to be removed from the surface and then blotted by the use of a dry sand cement mixture.

A number of other ways of accomplishing a uniformly dense, stronger concrete may suggest themselves to construction engineers. Certainly the goal seems to be well worth the slight cost of such experiments. There is no risk attached to them for the resulting pavements are almost certain to be more durable than those as ordinarily constructed.

The National Crushed Stone Association Safety Competition for 1935

By T. D. LAWRENCE and D. R. WHITE

Employment Statistics Section, Mineral Production and Economics Division, United States Bureau of Mines

◆ Krause No. 1 Quarry of the Columbia Quarry Co. wins contest. Eighteen other quarries receive honorable mention for completing year with no lost-time accidents

THE enrollment in the 1935 safety contest conducted by the United States Bureau of Mines in cooperation with the National Crushed Stone Association was represented by a total of 48 plants, two underground mines and 46 open quarries. In the open-quarry unit, 19 plants completed the contest year without an accident causing loss of time to any of the men.

The yearly safety contests for crushed stone quarries are based upon reports of accidents and man-hours of exposure which are submitted to the United States Bureau of Mines by the competing companies. The reports are analyzed by the Bureau; the accident-frequency and accident-severity rates are computed for each plant, and the plants are graded according to the accident-severity rates. The plant having the lowest severity rate, or, if two or more plants had no accidents, the plant having the largest number of man-hours of employment to its credit, is considered as having established the best safety record, and is therefore awarded the safety trophy. The trophy for the annual award is provided by *The Explosives Engineer* magazine. All plants, other than the winner of the trophy, that were operated without a lost-time accident during the contest year are awarded certificates of honorable mention for their achievements in the promotion of safety.

Krause No. 1 quarry, near Columbia, Ill., operated by the Columbia Quarry Company, won first place in the 1935 contest and will be awarded the safety trophy for that year. This quarry operated 167,671 man-hours without a lost-time accident during the contest period, maintaining its accident-free record of the two previous years, 1933 and 1934. The total operating time during the three years was 502,656 man-hours.

The 18 other quarries that operated without a lost-time accident and which therefore will be awarded certificates of honorable mention are shown in the following list:

1.—Holston limestone quarry, Mascot, Knox County, Tenn., operated by the American Limestone Co. Quarry operated 122,934 man-hours in 1935.

2.—Cape Girardeau limestone quarry, Cape Girardeau, Cape Girardeau County, Mo., operated by the Marquette Cement Manufacturing Co. Quarry operated 111,928 man-hours in 1935.

3.—North Branford trap-rock quarry No. 7, North Bradford, New Haven County, Conn., operated by the New Haven Trap Rock Co. Quarry operated 95,061 man-hours in 1935.

4.—Piqua limestone quarry, Piqua, Miami County, Ohio, operated by the Ohio Marble Co. Quarry operated 87,370 man-hours in 1935.

5.—Berkeley Nos. 5 and 6 limestone quarry, Martinsburg, Berkeley County, W. Va., operated by the North American Cement Corporation. Quarry operated 84,396 man-hours in 1935.

6.—Security limestone quarry, Security, Washington County, Md., operated by the North American Cement Corporation. Quarry operated 75,967 man-hours in 1935.

7.—Blue Mount serpentine quarry, White Hall, Baltimore County, Md., operated by the J. E. Baker Co. Quarry operated 69,811 man-hours in 1935.

8.—Pembroke limestone quarry, Pembroke, Giles County, Va., operated by the Pembroke Limestone Corporation. Quarry operated 57,982 man-hours in 1935.

9.—White Haven limestone quarry, White Haven, Luzerne County, Pa., operated by the General Crushed Stone Co. Quarry operated 57,012 man-hours in 1935.

10.—Union limestone quarry, Mt. Wolf, York County, Pa., operated by the J. E. Baker Co. Quarry operated 53,487 man-hours in 1935.

11.—Middlefield No. 1 trap-rock quarry, New Haven County, Conn., near Middlefield, Middlesex County, Conn., operated by the New Haven Trap Rock Co. Quarry operated 52,575 man-hours in 1935.

12.—Union Furnace limestone quarry, Huntingdon County, Pa., near Tyrone, Blair County, Pa., operated by the American Lime & Stone Co. Quarry operated 47,278 man-hours in 1935.

13.—Thomasville Quarry, Thomasville, York County, Pa., operated by the J. E. Baker Co. Quarry operated 46,626 man-hours in 1935.

14.—Plainville No. 4 trap-rock quarry, Plainville, Hartford County, Conn., operated by the New Haven Trap Rock Co. Quarry operated 45,079 man-hours in 1935.

15.—Gasport limestone quarry, Gasport, Niagara County, N. Y., operated by the Wickwire Spencer Steel Co. Quarry operated 42,491 man-hours in 1935.

16.—Catskill limestone quarry, Alsen, Greene County, N. Y., operated by the North American Cement Corporation. Quarry operated 39,277 man-hours in 1935.

17.—Summitville limestone quarry, Summitville, Coffee County, Tenn., operated by the Tennessee Cement and Lime Co. Quarry operated 20,132 man-hours in 1935.

18.—Rocky Hill No. 3 quarry, Rocky Hill, Hartford County, Conn., operated by The New Haven Trap Rock Company. Quarry operated 15,374 man-hours in 1935.

The period of operation of the 48 individual plants that were enrolled in the contest ranged from 473,660 man-hours down to 15,374 man-hours of exposure. The accident-frequency ranged from zero to 276.8 accidents per million man-hours; and the accident-severity rates ranged from zero to 106.8 days lost per thousand man-hours of operation. The average time lost per accident at the open quarries, including the charges for deaths and permanent disabilities, was 351 days. The average duration of disability for temporary injuries only at the open quarries was 39 days.

The accident-frequency rate for the open quarries in 1935 was the best attained since these yearly contests were inaugurated in 1926, and the corresponding rate for the underground group was better than any other year except 1931.

The total number of man-hours worked in 1935 by the open quarries was 4,166,306 and that for the underground mines was 175,994. Combined they show an increase of more than 22 per cent over like figures for the year 1934.

The 19 open quarries that operated without an accident during the year account for more than 31 per cent of the total number of man-hours worked by this group of quarries. The remaining 27 quarries were responsible for 88 accidents. Two accidents resulted fatally and there was one permanent total disability; these three cases represented a loss of 6,000 days lost each. Eight permanent partial disabilities carried a time-loss charge of 9,900 days; and 77 temporary resulted in 3,015 days of disability to the injured men.

Only three injuries occurred at the underground operations and each was of a temporary nature.

The relative standing of each group of plants, arranged according to their accident-severity rates, is shown in tables 1 and 2.

Average Length of Disability per Injury

Figures for the 11-year period, 1925 to 1935, covering the number of accidents and the number of days of disability of the injured employees, revealed an average of 19.5 days of disability per temporary lost-time injury at plants in the open-quarry group and 17.6 days at plants in the underground-mine group. Permanent-partial disabilities at open quarries during the same years numbered 57; these accidents, when weighted according to nature of injury and part of body affected as provided by standard methods, had a total time-charge of 74,618 days of disability, an average of 1,309 days per injury. The deaths and permanent total disabilities are weighted uniformly at 6,000 lost-days each.

Compensation Costs

The compensation costs of the deaths and injuries resulting from accidents at crushed stone quarries and mines enrolled in the contest are not shown on the reports furnished to the Bureau of Mines. In fact, in most cases the compensation costs are probably not even known by the companies when their accident reports are sent to the Bureau, as the reports are usually made before the compensation costs have been determined. However, assuming an average cost of $5,000 per death and $100 per non-fatal injury, a basis for estimating the accident costs may be established. On this basis, the assumed cost of accidents at all enrolled plants in 1926 (the first

TABLE I.—RELATIVE STANDING OF PLANTS IN THE 1935 NATIONAL CRUSHED STONE ASSOCIATION SAFETY CONTEST BASED UPON THE ACCIDENT SEVERITY RATES OF THE PLANTS (QUARRY GROUP)[1]

Code No.	Group No.	Hours worked	Number of accidents					Number of days lost					Frequency rate	Severity rate
			Fatal	P.T.	P.P.	Temp.	Total	Fatal	P.T.	P.P.	Temp.	Total		
1	1	167,671	----	----	----	----	----	----	----	----	----	----	.000	.000
2	2	122,934	----	----	----	----	----	----	----	----	----	----	.000	.000
3	3	111,928	----	----	----	----	----	----	----	----	----	----	.000	.000
4	4	95,061	----	----	----	----	----	----	----	----	----	----	.000	.000
5	5	87,370	----	----	----	----	----	----	----	----	----	----	.000	.000
6	6	84,396	----	----	----	----	----	----	----	----	----	----	.000	.000
7	7	75,967	----	----	----	----	----	----	----	----	----	----	.000	.000
8	8	69,811	----	----	----	----	----	----	----	----	----	----	.000	.000
9	9	57,982	----	----	----	----	----	----	----	----	----	----	.000	.000
10	10	57,012	----	----	----	----	----	----	----	----	----	----	.000	.000
11	11	53,487	----	----	----	----	----	----	----	----	----	----	.000	.000
12	12	52,575	----	----	----	----	----	----	----	----	----	----	.000	.000
13	13	47,278	----	----	----	----	----	----	----	----	----	----	.000	.000
14	14	46,626	----	----	----	----	----	----	----	----	----	----	.000	.000
15	15	45,079	----	----	----	----	----	----	----	----	----	----	.000	.000
16	16	42,491	----	----	----	----	----	----	----	----	----	----	.000	.000
17	17	39,277	----	----	----	----	----	----	----	----	----	----	.000	.000
18	18	20,132	----	----	----	----	----	----	----	----	----	----	.000	.000
19	19	15,374	----	----	----	----	----	----	----	----	----	----	.000	.000
20	20	99,867	----	----	----	2	2	----	----	----	8	8	20.027	.080
21	21	50,411	----	----	----	1	1	----	----	----	5	5	19.837	.099
22	22	392,278	----	----	----	4	4	----	----	----	56	56	10.197	.143
23	23	48,418	----	----	----	1	1	----	----	----	10	10	20.653	.207
24	24	130,445	----	----	----	4	4	----	----	----	44	44	30.664	.337
25	25	27,742	----	----	----	2	2	----	----	----	16	16	72.093	.577
27	26	136,792	----	----	----	4	4	----	----	----	89	89	29.241	.651
28	27	73,441	----	----	----	1	1	----	----	----	62	62	13.616	.844
29	28	58,063	----	----	----	2	2	----	----	----	57	57	34.445	.982
30	29	155,064	----	----	----	14	14	----	----	----	160	160	90.295	1.032
31	30	31,424	----	----	----	1	1	----	----	----	35	35	31.823	1.114
32	31	26,844	----	----	----	1	1	----	----	----	41	41	37.252	1.527
33	32	52,004	----	----	----	4	4	----	----	----	90	90	76.917	1.731
34	33	87,356	----	----	----	5	5	----	----	----	155	155	57.237	1.774
36	34	44,980	----	----	----	1	1	----	----	----	145	145	22.232	3.224
37	35	434,361	----	----	1	1	2	----	----	1,500	51	1,551	4.604	3.566
38	36	33,705	----	----	----	1	1	----	----	----	163	163	29.669	4.636
39	37	62,142	----	----	1	0	1	----	----	300	----	300	16.092	4.828
40	38	66,753	----	----	1	1	2	----	----	300	26	326	29.961	4.884
41	39	60,345	----	----	1	----	1	----	----	300	----	300	16.571	4.971
42	40	42,622	----	----	1	----	1	----	----	300	----	300	23.462	7.039
43	41	41,827	----	----	1	1	2	----	----	300	61	361	47.816	8.631
44	42	21,780	----	----	----	3	3	----	----	----	207	207	137.741	9.504
45	43	473,660	1	1	----	3	5	6,000	6,000	----	1,082	13,082	10.556	27.619
46	44	137,189	1	----	----	8	9	6,000	----	----	284	6,284	65.603	45.805
47	45	40,985	----	----	1	1	2	----	----	2,400	39	2,439	48.798	59.510
48	46	43,357	----	----	1	11	12	----	----	4,500	129	4,629	276.772	106.765
Totals and rates, 1935		4,166,306	2	1	8	77	88	12,000	6,000	9,900	3,015	30,915	21.122	7.420
Totals and rates, 1934		3,288,257	1	0	2	106	109	6,000	0	2,850	1,873	10,723	33.148	3.261

[1] As the accident reports from mining companies are considered confidential by the Bureau of Mines, the identities of the plants to which this table relates are not revealed. Frequency rate indicates number of fatal, permanent, and other lost time accidents per million man-hours of exposure; severity rate indicates number of days lost from accidents per thousand man-hours.
Note: P.T. means permanent total disability; P.P. means permanent partial disability; and Temp. means temporary disability.

TABLE II.—RELATIVE STANDING OF PLANTS IN THE 1935 NATIONAL CRUSHED STONE ASSOCIATION SAFETY CONTEST BASED UPON THE ACCIDENT SEVERITY RATES OF THE PLANTS (UNDERGROUND-MINE GROUP)[1]

Product	Code No.	Group No.	Hours worked	Number of accidents					Number of days lost					Frequency rate	Severity rate
				Fatal	P. T.	P. P.	Temp.	Total	Fatal	P. T.	P. P.	Temp.	Total		
Limestone	26	1	77,045	--	--	--	1	1	--	--	--	45	45	12.979	.584
Limestone	35	2	98,949	--	--	--	2	2	--	--	--	204	204	20.212	2.062
Totals and averages,	1935		175,994	0	0	0	3	3	0	0	0	249	249	17.046	1.415
Totals and averages,	1934		248,146	0	0	0	13	13	0	0	0	287	287	52.389	1.157

[1] See footnotes for table 1.

yearly contest) was $6.82 per thousand man-hours of exposure to risk; the corresponding figure for 1935 for all companies in the contest was $4.35 per thousand hours of exposure. Another comparison may be made between the estimated costs for all plants enrolled in the first five yearly contests (1926 to 1930) and the estimated costs for all plants enrolled in the latest five years (1931 to 1935). On this basis the accident costs were $8.63 per thousand man-hours of exposure during the earlier period and $5.45 per thousand man-hours during the more recent five-year period. These figures relate to all plants, both open quarries and underground mines, that have participated in the crushed-stone safety contests from 1926 to 1935. The figures show an estimated saving of $3.18 per thousand man-hours of exposure in 1931 to 1935 as compared with 1926 to 1930, a total saving of approximately $60,000 for all enrolled plants during the last 5 years, and an average saving of $246 per plant per year over the 5-year period.

Review of Safety Record of Crushed Stone Plants

During the 10 years in which these safety contests, sponsored by the National Crushed Stone Association, have been conducted by the Bureau of Mines, the accident frequency rates per million man-hours of exposure for the open-quarry group have ranged from 59.5 in 1927 to 21.1 in 1935, the rate for 1935 being the best during the period of the contests. As shown in table 3, the frequency rate was 40.8 in 1926, the first contest-year, representing a reduction from 60.7 in 1925, the year preceding the inauguration of the contest. The severity rate was 6.7 in the year preceding the contest and this rate was lowered to 5.9 in 1926, the first contest year. The 1935 rate was less favorable than the rates for any other years except 1927, 1928 and 1931.

Yearly rates for the underground group are of little if any significance as typifying occupational risk, because of the small number of plants covered. However, the 11-year frequency rate for the underground group was 56.0 accidents per million man-hours of exposure as compared with 40.6 for the open-quarry group, and the 11-year severity-rate was 6.9 per thousand man-hours of exposure as compared with 6.5 for the open-quarry unit.

A special compilation showing the causes of accidents at the plants enrolled in the crushed-stone safety contest has not been made. It is probable, however, that the cause of the accidents at those plants were similar in all essentials to the causes of accidents at crushed stone plants in general; these are shown in yearly bulletins entitled "Quarry Accidents in the United States", published by the Bureau of Mines.

TABLE III.—YEARLY SUMMARY—NATIONAL CRUSHED STONE ASSOCIATION SAFETY CONTEST, 1926-1935[1]

Year	Plants	Hours worked	Number of accidents					Number of days lost					Frequency rate	Severity rate
			Fatal	P. T.	P. P.	Temp.	Total	Fatal	P. T.	P. P.	Temp.	Total		
OPEN QUARRIES														
1925	38	4,927,402	4	----	3	292	299	24,000	----	3,600	5,286	32,886	60.681	6.674
1926	40	5,298,983	3	----	6	207	216	18,000	----	9,000	4,239	31,239	40.763	5.895
1927	48	7,876,791	9	----	2	458	469	54,000	----	2,100	7,186	63,286	59.542	8.034
1928	53	7,509,098	8	----	4	322	334	48,000	----	8,700	5,493	62,193	44.479	8.282
1929	53	7,970,325	4	----	5	286	295	24,000	----	5,760	5,533	35,293	37.012	4.428
1930	68	8,013,415	6	----	9	227	242	36,000	----	7,250	3,671	46,921	30.199	5.855
1931	58	5,085,857	4	----	13	198	215	24,000	----	18,660	3,540	46,200	42.274	9.084
1932	40	2,661,850	1	----	4	75	80	6,000	----	6,750	2,481	15,231	30.054	5.722
1933	40	2,704,871	1	----	1	67	69	6,000	----	48	2,893	8,941	25.510	3.306
1934	46	3,288,257	1	----	2	106	109	6,000	----	2,850	1,873	10,723	33.148	3.261
1935	46	4,166,306	2	1	8	77	88	12,000	6,000	9,900	3,015	30,915	21.122	7.420
Total 11 years		59,503,155	43	1	57	2,315	2,416	258,000	6,000	74,618	45,210	383,828	40.603	6.451
UNDERGROUND MINES														
1925	3	400,672	--	----	--	29	29	------	----	----	228	228	72.378	0.569
1926	3	517,926	--	----	--	34	34	------	----	----	533	533	65.646	1.029
1927	2	318,449	1	----	1	14	16	6,000	----	300	68	6,368	50.244	19.997
1928	5	542,193	1	----	1	68	70	6,000	----	300	888	7,188	129.105	13.257
1929	4	665,520	1	----	1	30	32	6,000	----	300	617	6,917	48.083	10.393
1930	6	595,367	1	----	1	15	17	6,000	----	225	468	6,693	28.554	11.242
1931	3	345,105	--	----	--	4	4	------	----	----	147	147	11.591	.426
1932	2	158,450	--	----	--	6	6	------	----	----	165	165	37.867	1.041
1933	3	229,381	--	----	--	11	11	------	----	----	349	349	47.955	1.521
1934	4	248,146	--	----	--	13	13	------	----	----	287	287	52.389	1.157
1935	2	175,994	--	----	--	3	3	------	----	----	249	249	17.046	1.415
Total 11 years		4,197,203	4	0	4	227	235	24,000	0	1,125	3,999	29,124	55.990	6.939

[1] Frequency rate indicates the number of fatal, permanent, and other lost-time accidents per million man-hours of exposure; severity rate indicates the number of days lost from accidents per thousand man-hours.

Note: P.T., permanent total disability; P.P., permanent partial disability; Temp., temporary disability. The National Crushed Stone Association safety contest began in 1926; figures for 1925 for company members are given for comparison.

National Safety Congress and Exposition Will Be Held in Atlantic City, October 5-9

THE "G-men" of the accident prevention world—several thousand members of the National Safety Council—will gather from all parts of the United States October 5 to 9 in Atlantic City, New Jersey, for the Twenty-Fifth National Safety Congress and Exposition.

Nearly 400 speakers will emphasize accident prevention in industrial plants, on the street, in the home, in the schools, in the air, in the streets. Judging from the advance reservations made at the three headquarters hotels, the Chelsea, the Ritz-Carlton, and the Ambassador, the meetings will be attended by approximately 12,000 delegates and visitors.

The 150 different sessions will be held in the headquarters hotels and the Atlantic City Auditorium, largest building of its kind in the world.

The Exposition and huge display of equipment for safeguarding dangerous operations of all kinds will be held in the Grand Ballroom of the Auditorium.

Separate programs have been arranged for industries in the more than thirty sections of the Council such as Cement, Chemical, Construction, Mining, Quarrying, Public Utilities, and others. There will be general sessions on industrial health, industrial nursing, occupational diseases, and safety equipment. Of particular interest to the crushed stone industry will be the meetings of the Quarry Section scheduled to take place in the Chelsea Hotel, Street Level, Parlor C, on Wednesday morning, October 7, and on Thursday morning, October 8, both sessions opening at 9:45 A. M.

The National Safety Council, under whose supervision the Twenty-Fifth National Safety Congress is being held, has for many years been recognized as one of the leading exponents of accident prevention. Through the Quarry Section the Council has rendered valuable aid to crushed stone producers in this important field and members of our industry who find it possible to attend can rest assured that they will obtain a wealth of interesting information of real practical value in their efforts to decrease accidents in crushed stone plants.

◆ Interesting program to be presented before meeting of Quarry Section at Chelsea Hotel, October 7-8

The National Safety Council extends a most cordial invitation to all interested in accident prevention to attend the Atlantic City conference whether or not members of the Council and to their invitation we wish to add our earnest suggestion that crushed stone producers make a special effort to at least be present during the meetings of the Quarry Section on Wednesday and Thursday. Following are the programs scheduled for the two meetings of the Quarry Section:

WEDNESDAY MORNING, OCTOBER 7

9:45 Report of General Chairman Alexander Foster, Jr.
10:00 Report of Secretary and News Letter Editor N. B. Sipe.
10:15 "The Viewpoint of the Employer Toward a Safety Program"—Otho M. Graves, Pres., General Crushed Stone Co., Easton, Pa.
10:45 Discussion.
11:00 "A Safety Program for the Crushed Stone Industry"—F. B. Kimball, Supt., Middlefield Plant, New Haven Trap Rock Co., New Haven, Conn.
11:30 "A Safety Program for the Sand and Gravel Industry"—Franklin K. Wills, Supt., Morrisville Plant, Warner Co., Philadelphia, Pa.
12:00 Discussion.

THURSDAY MORNING, OCTOBER 8

9:45 "Silicosis: An Occupational Hazard"—Dr. Roy R. Jones, Division of Labor Standards, U. S. Department of Labor, Washington, D. C.
10:15 Discussion.
10:30 "What the Employer Should Know About Silicosis"—Theodore C. Waters, Mullikin, Stockbridge & Waters, Baltimore, Md.
11:00 Discussion.
11:15 Election of Officers.
11:30 General Discussion: The Work of the Quarry Section.

MANUFACTURERS' DIVISION

of the

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These associate members are morally and financially aiding the Association in its efforts to protect and advance the interests of the crushed stone industry. Please give them favorable consideration whenever possible.

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Tests for the Traffic Durability of Bituminous Pavements

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IN CONJUNCTION WITH THE

Twentieth Annual Convention

OF THE

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Netherland Plaza Hotel — Cincinnati, Ohio

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• • AN EXCELLENT opportunity for manufacturers of machinery, equipment and supplies used in the production of crushed stone to bring their products to the intimate attention of the foremost producers of the United States and Canada and under particularly favorable circumstances.

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